



Log 2236

National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

Date: May 30, 1990
In reply refer to : A-90-70 through -75

Honorable James B. Busey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On June 19, 1987, the National Transportation Safety Board issued Safety Recommendations A-87-77 through -89 to the Federal Aviation Administration (FAA) suggesting action to improve flight recorder standards. In response, the FAA made significant improvements in the standards, resulting in the enhancement of aircraft accident investigation capabilities. Accident investigation experience, however, continues to reveal the need for additional action in the areas of maintenance requirements and operating standards to further ensure the availability and the reliability of cockpit voice recorders (CVRs), flight data recorders (FDRs), and digital flight data recorders (DFDRs) for accident investigation and prevention purposes.

Background

On April 13, 1978, as a result of deficiencies found in maintenance programs and testing procedures following investigations in 1977 and 1978, the Safety Board issued the following safety recommendations to the FAA:

A-78-21

Review the adequacy of current cockpit voice recorder preflight testing procedures to assure satisfactory system operation.

A-78-22

Review the reliability of cockpit voice recorder units to assure that the mean time between failure is not excessive.

The FAA took corrective actions, and the Safety Board classified the two recommendations as "Closed--Acceptable Action." However, the following accidents prompted further action by the Safety Board:

September 22, 1981, Air Florida DC-10, Miami, Florida. An engine failed on takeoff. The Sundstrand V-557 CVR tape was unusable because it exhibited large speed fluctuations and distortion.

February 16, 1982, Reeve Aleutian Airways YS-11, King Salmon, Alaska. The airplane crashed on landing. The Sundstrand V-557 CVR exhibited speed fluctuations. A transcript was difficult to prepare and spectrum analysis could not separate small rpm changes in the engines from the recorder speed fluctuations.

July 9, 1982, Pan American B-727, Kenner, Louisiana. The airplane crashed during takeoff after encountering a wind shear. The Sundstrand V-557 CVR exhibited excessive high noise, speed fluctuations, and distortion.

On July 13, 1982, the Safety Board issued Safety Recommendations A-82-62 and -63 asking for an evaluation of the performance of the Sundstrand V-557 CVR and removal of the recorder from U.S. fleets within a 2-year period. In its final response of January 24, 1983, to these recommendations, the FAA attributed the poor performance of the CVR on the Pan American flight to an internal open circuit in the erase head and classified it as an unusually rare type of failure. The FAA further added that, based on the preliminary information obtained, it did not believe a costly random check of Sundstrand V-557 CVRs and operators' maintenance programs was warranted. The FAA also stated that removal of the Sundstrand V-557 CVR from service after 2 years would not achieve the safety benefits needed to offset the costs involved.

On May 5, 1983, the Safety Board disagreed with the FAA's assessment stating that the performance of the CVR on the Pan American flight was not an isolated case and that the problems with the Sundstrand V-557 CVR were more widespread than recognized by the FAA. The Safety Board believed that the FAA did not take into account many previous reported discrepancies with the recorder; further, the Safety Board did not completely agree with the FAA's proposed solution to the problem by publishing Maintenance Bulletin 23-17, which required principal avionic inspectors to review the Sundstrand V-557 CVR maintenance programs of operators and to encourage the operators to use the recommended procedures where necessary. The Safety Board also found misleading information in the bulletin regarding the self-test circuit and redundancy features in the recorder. Based on the FAA response, the Safety Board classified Safety Recommendations A-82-62 and -63 as "Closed--Unacceptable Action" but was encouraged by the FAA's proposed program to review all CVR and FDR devices and with the FAA's assurances that it would keep the Safety Board informed of the results. However, the FAA did not report to the Safety Board the results of its review.

Since May 1983, the Safety Board has investigated or reviewed the investigations of the following 12 accidents and has found that investigation support from flight recorders continues to be unreliable at times, largely due to poor maintenance, inspection, and repair:

October 11, 1983, Flying Tigers B-747, Frankfurt, West Germany. During the takeoff roll a cargo pallet slid backward, causing a shift in the center of gravity and an unintended rotation of the airplane to a nose-up attitude. The takeoff was rejected. The airplane was substantially damaged. The accident report stated, in part:

Immediate reading of the registered data (of the DFDR) was not possible since the recorder was found to be defective and the recording medium advanced only by jerks. Only after repair was an evaluation possible.

December 18, 1983, Malaysian Airlines System A300, Kuala Lumpur, Malaysia. The airplane crashed during an instrument approach in instrument meteorological conditions and was destroyed by impact and fire; there were no fatalities. One of the investigation authority's findings was that "the DFDR provided no evidence to assist in the investigation because the recorder was inoperative."

December 23, 1983, Korean Air Lines DC-10, Anchorage, Alaska. During reduced visibility conditions the flightcrew became disoriented while selecting the takeoff runway and collided with another airplane during the takeoff roll. Both airplanes were destroyed; there were no fatalities. The CVR was not located; the DFDR had malfunctioned and was not operating during the accident.

September 18, 1984, Compania AECA DC-8, Quito, Ecuador. After using the full length of the 10,236-foot runway on an unscheduled cargo flight from Miami, Florida, to its final destination at Guayaquil, Ecuador, the airplane failed to climb and crashed into some houses. The 4 crewmembers and 49 people on the ground were killed. The accident was caused by a mispositioned horizontal stabilizer. The investigation was hampered by the absence of recorded data. The tape from the Sundstrand V-557 CVR was incinerated. The FDR was not operating at the time of the accident; it had not been maintained properly and the same side of the foil had been used three times.

January 21, 1985, Galaxy Airlines L-188, Reno, Nevada. Shortly after a night takeoff, the flightcrew of the charter flight reported heavy vibrations in the airplane and obtained permission to return to the airport. About 30 seconds later the airplane stalled and crashed. Only 1 of the 71 occupants survived. The accident was caused by the lack of flightcrew coordination following the onset of vibration due to an unsecured air start access door. The FDR was not operating at the time of the accident. The foil supply spool was empty. All of the foil was wound on the takeup spool and sealed with a piece of tape. The airplane was operated 117 hours after the foil had run out.

December 11, 1985, Arrow Air DC-8, N950JW, Gander, Newfoundland, Canada. N950JW was an international charter flight with 248 U.S. Army soldiers on board returning to the United States from the Middle East. According to the investigation authority's report, the airplane stalled at a low altitude after liftoff and crashed killing all 256 passengers and crew. The cockpit area microphone channel (CAM) on the Sundstrand AV-557A CVR did not record flightcrew conversations. The FDR vertical acceleration stylus marks were substandard and the data were intermittent.

August 31, 1986, midair collision between Aeromexico DC-9 and a Piper PA28-181, Cerritos, California. The Aeromexico flight was on an initial approach radar vector to the Los Angeles Airport heading northwest under instrument flight rules, and the Piper was on a pleasure flight heading east under visual flight rules when the two airplanes collided killing all 64 persons on board the DC-9, the 3 occupants of the Piper, and 15 people on the ground. The CVR cockpit area microphone channel on the DC-9's Sundstrand V-557 CVR was of poor quality because of improper tape tension around the capstan.

January 13, 1988, Challenge Air Cargo B-707, (U.S. registry), Bogota, Columbia. The nosegear collapsed and separated on landing. The FDR calibration data did not contain intermediate values for altitude, airspeed, and heading, and it was not useful in performing a readout.

January 20, 1989, United Express, Convair 580, Buena Vista, Colorado. During cruise flight the right engine was secured because of an indication of a potential gearbox oil pressure failure. Shortly thereafter, the left engine failed and a forced landing was made injuring five passengers. The Sundstrand V-557 CVR was of poor quality and had no bias signal.

February 8, 1989, Independent Air, Inc., B-707, N7231T, Santa Maria Island, Azores. The airplane was on an instrument approach descending through clouds when it struck a mountain 11 miles east of the airport. All 144 occupants of the airplane were killed in the accident. The FDR calibration data did not contain intermediate values for altitude, airspeed, and heading.

June 7, 1989, Suriname Airways DC-8, N1809E, Paramaribo, Suriname. The airplane was on its landing approach in dense fog and crashed several miles short of the runway. A total of 169 of the 182 occupants on board were killed. The FDR altitude recording mechanism was inoperative. The calibration data did not contain intermediate values for altitude, airspeed, and heading.

July 13, 1989, Rosenbalm Aviation, Inc., DC-8, N950R, Vandalia, Ohio. The airplane struck a parked B-727 while taxiing on the parking ramp after completion of a night flight. Both aircraft were damaged substantially. The Sundstrand V-557 had a poor quality recording with a loud background noise present. A large portion of recorded information on the cockpit area microphone channel was unintelligible.

Serviceability of Flight Recorders

In a 1975 study of FDR readout experience in aircraft accident investigations,^{1/} the Safety Board concluded that recorder malfunctions primarily resulted from personnel error and inadequate maintenance. Based on the investigation experience of the past 10 years, as demonstrated by the accidents here, these same kinds of malfunctions continue to exist. Maintaining flight recorders in a serviceable condition is an important area of the air carriers' responsibility to flight safety, but some operators are overlooking this responsibility.

The Safety Board believes that these kinds of problems can be eliminated or at least reduced significantly. As stated in the Safety Board's April 13, 1978 letter transmitting Safety Recommendations A-78-21 and -23, a CVR malfunction often can be detected easily with a simple maintenance or preflight check. Most CVRs have a test feature that allows a crewmember to check the proper functioning of the recorder by plugging into the test jack in the CVR control unit, pushing a test button, listening for the test tone through a headset, and noting the proper indication on the test meter or light in the unit. However, as the Safety Board stated in its May 5, 1983 letter to the FAA, many Sundstrand V-557 CVRs that self-tested satisfactorily were later found to have poor audio recordings. Therefore, brief monitoring of a radio transmission and cockpit conversation while plugged into the test jack must be an essential part of the CVR function check in order to determine the quality of the audio recording. Such monitoring would require only seconds to perform and should be a part of any maintenance or preflight check.

Furthermore, the Safety Board reiterates its position, discussed in its May 5, 1983 reply to the FAA's response to Safety Recommendations A-82-62 and -63 regarding the poor performance of the Sundstrand V-557 CVR, that continuous-recording, self-monitoring circuitry for CVRs is needed. This feature is currently incorporated within DFDRs, and the FAA should revise the CVR Technical Standard Order (TSO) to ensure that such circuitry is incorporated within future CVR standards.

Except for some foreign operators in the United States, the increased reliability of state-of-the-art DFDRs and the recent rule requiring DFDRs on board U.S. air carriers will eliminate most of the type of FDR malfunctions encountered previously. However, new technology alone cannot solve all

^{1/} National Transportation Safety Board Special Study--Flight Data Recorder Readout Experience in Aircraft Accident Investigations, 1960-1973, (NTSB-AAS-75-1), May 14, 1975.

potential flight recorder problems. Operators must make a commitment to ensure this equipment is functioning properly.

Finally, the Safety Board acknowledges the FAA's actions, reported in its letter of July 21, 1989, to correct improper calibration checks by a recorder repair station in Miami, Florida. However, the Safety Board believes that such improper calibrations may be more widespread than recognized by the FAA. The investigation of the Suriname Airways accident on June 7, 1989 has that another repair station in Miami has also performed improper calibration checks.

Master Minimum Equipment List Policy

Both the CVR and FDR were inoperative on the airplane involved in the Gander accident. This circumstance occurred because of an FAA practice that permitted air carriers to operate with both flight recorders inoperative for a short time until repairs could be made. The Canadian Aviation Safety Board's report of the accident concluded that the flight recorders should not have been deferred maintenance items.

The Safety Board understands that the current FAA policy ^{2/} requires at least one flight recorder operating at all times. The inoperative recorder is placed in a category "B" repair interval, which means that the operator must have the recorder repaired or replaced within 3 consecutive calendar days or 72 hours, excluding the day the malfunction was recorded.

The Safety Board appreciates the FAA's action to correct the unacceptable practice of operating without any functional recorder and recognizes the FAA's attempt to reestablish the minimum level of safety intended by the rules governing flight recorders. The Board also recognizes the need to eliminate any ambiguities that may have existed in formulating previous master minimum equipment lists (MMEs). However, the Board does not agree with placing inoperative recorders in the category "B" repair interval and remains concerned that commercial flight operations may continue with inoperative flight recorders.

The Safety Board is fully aware that inoperative flight recorders do not affect the airworthiness of an aircraft. In some cases, however, the absence of flight recorder data following an accident could raise serious questions about the airworthiness of an aircraft. For example, the airworthiness of the B-747 would likely have come into question had the China Airlines B-747 crashed into the Pacific Ocean on January 19, 1985, and had the flight recorders not been recovered. Later in 1985, the air transport industry and government authorities may have had to consider grounding the B-747 fleet when

^{2/} As expressed in FAA letter from the Air Transport Division Manager to all Regional Flight Standards Division and Aircraft Evaluation Group Managers, dated December 15, 1987, and as further modified by a letter dated February 10, 1989, from the Assistant Manager, Air Transport Division to Regional Flight Standards Division Managers regarding the policy definition of a master minimum equipment list (MMEs).

the Air India B-747 crashed into the North Atlantic Ocean on June 23, 1985, and when the Japan Air Lines B-747 crashed at Nagano, Japan, on August 12, 1985. Fortunately, the China Airlines flightcrew recovered control of the airplane, and the subsequent readout of the flight recorders disclosed that the incident was not the result of an airworthiness problem. The data were later available to show that the incident was unrelated to the other two accidents. Looking to the future, this MMEL policy could jeopardize confidence in the airworthiness of fly-by-wire aircraft, such as the Airbus A320, in the event of a serious accident.

The current MMEL policy presumes that investigators will not be hindered greatly by having information from only one recorder. Accident investigation experience, however, has shown the need for simultaneous operation of both recorders. The information provided by each recorder complements the other and should not be treated as separable. One type of recorder is not necessarily more valuable than the other. A policy of permitting air carriers to dispatch with only one flight recorder operative could result in diminishing the effectiveness of an investigation if only the inoperative recorder is recovered after an accident. After a South African Airways B-747 crashed into the Indian Ocean on November 29, 1987, only the CVR was recovered from a depth of 14,500 feet. The DFDR could not be located. Fortunately, the CVR information was sufficient to corroborate other physical evidence to establish that a fire had occurred in the main deck cargo compartment.

The Safety Board recognizes that it may be difficult for some operators, particularly international operators, to repair or replace a recorder at the aircraft's next destination. The Board also recognizes that the FAA's current MMEL policy eliminated the disparity between carriers' MMEL policies that existed previously. Nevertheless, the Safety Board believes that flight recorders must be made operable at the earliest opportunity, and that an arbitrary timeframe, such as 3 days or 72 hours, for accomplishing this objective may not be appropriate for all carriers and for all types of aircraft. For example, the Safety Board does not believe that it would be prudent for a carrier to dispatch an Airbus A320 at any time with an inoperative DFDR. Such a device would be absolutely essential to an investigation in the event of an accident or incident. When an Air France A320 crashed on June 26, 1988, at Mulhouse-Habsheim Airport in France, much controversy arose over the airworthiness of aircraft operated by fly-by-wire systems. Readout and examination of the DFDR data determined that airworthiness was not an issue.

The Safety Board concludes that the FAA should be more specific about when an air carrier must have operable flight recorders on board and the circumstances under which an air carrier may operate briefly with inoperative recorders. This determination should consider the type of equipment used, routes flown, and maintenance and repair capabilities. The MMEL appears to provide for some selectivity under category "A," which requires inoperative equipment to be repaired within the time interval specified by each operator's MEL. For example, the carrier could be required to terminate a flight at the next destination where repairs can be made and to limit the flight to a specified maximum number of takeoffs and landings until the repairs are made. The Safety Board encourages the FAA to find ways to improve its policy in order to ensure that flight recorder data will be available, to the maximum extent possible, on board U.S. air carrier aircraft.

Foreign Operators

The investigation of foreign operator accidents and incidents in the United States is no less difficult or important than the investigation of occurrences involving United States operators. The Safety Board remains concerned with the prospect of having to investigate an accident involving a foreign air carrier airplane that is not equipped with state-of-the-art flight recorders. In view of the technological improvements to recorders and in view of the efforts to produce improved standards, the Safety Board believes that foreign operators in the United States should be subject to the improved U.S. standards for flight recorders.

Title 14 CFR Part 129, "Operations: Foreign Air Carriers and Foreign Operators of U.S. Registered Aircraft Engaged in Common Carriage," requires foreign operators of aircraft in the United States to adhere to the standards and recommended practices listed in Part I (International Commercial Air Transport) of Annex 6 to the Convention of the International Civil Aviation Organization (ICAO). Currently, the United States must rely on the ICAO standards and recommended practices when the flight recorder requirements of foreign aircraft operators are inferior to U.S. standards. The Safety Board recognizes that many countries who are members of ICAO have readily adopted ICAO standards and that these standards, improved and adopted in November 1985, are similar to the current U.S. standards. While the ICAO standards in Annex 6 are a significant improvement over earlier requirements, some of these standards are less stringent than U.S. requirements.

For example, ICAO requires foreign air carrier operators to equip large (over 12,500 pounds maximum certificated takeoff gross weight) turbine engine-powered airplanes, issued certificates of airworthiness before January 1, 1987, with only 5-parameter FDRs. Additionally, turbine engine-powered airplanes, issued type certificates after September 30, 1969, and issued individual certificates of airworthiness on or after January 1, 1987, but before January 1, 1989, are required to be equipped with only 15-parameter FDRs. The United States requires domestic air carrier operators to equip these airplanes with 6-parameter DFDRs. Further, the United States requires that large airplanes with advanced electronic systems and navigational cathode ray tube (CRT) displays (incorporating the digital data bus and the ARINC 717 digital flight data acquisition unit) must be equipped with 32-parameter DFDRs regardless of when the certificate of airworthiness was issued. As a result, U.S. standards required the removal of metal foil FDRs from U.S. fleets before May 26, 1989. While ICAO recognizes that metal foil FDRs do not meet the requirements of the new U.S. flight recorder standards, ICAO only recommends that their use be discontinued as soon as practicable.

Furthermore, U.S. standards require that large airplanes type-certificated up to and including September 30, 1969, for operations above 25,000 feet altitude, or for turbine engine-powered airplanes certificated before September 30, 1969, be required to contain DFDRs with 11 parameters before May 26, 1994. For large airplanes certified for operations above 25,000 feet, type-certificated after September 30, 1969, or for large airplanes and turbine engine-powered airplanes manufactured after May 26, 1989, 17-parameter DFDRs must be installed. For airplanes in a similar category, ICAO requires only 5-parameter FDRs unless the airplane is over 59,500 pounds, in which case a 32-parameter recorder is required.

Title 14 CFR Part 129 does not provide the United States with the regulatory means to require foreign operators to meet the improved standards in flight recorder technology. This rule states, in part, "Each foreign air carrier shall conduct its operations within the United States in accordance with operations specifications issued by the [FAA] Administrator..." and in the case of leased U.S.-registered aircraft, each foreign operator must adhere to an FAA-approved MEL for the aircraft. The rule is general in nature and does not address flight recorder requirements. The Safety Board recognizes that foreign operators of U.S.-registered airplanes probably would maintain them as equipped by U.S. owners/operators with updated recorders. However, Part 129 does not provide the FAA with the means to enforce the updated standards. The Safety Board believes that foreign operators that operate in the United States should not be exempt from improved recorder standards, particularly the requirement eliminating the use of the foil FDRs.

Accident investigation experience has shown that flight recorders are indispensable in providing definitive and timely answers to the causes of accidents and incidents in the increasingly technical and complex aviation industry. The use of recorders benefits the industry and the public. Technological and regulatory improvements in flight recorders result in safety benefits only with concurrent attention to inspection, maintenance and use of this equipment. Consequently, the effectiveness of the Safety Board's contribution to aviation safety rests with the industry's full support of flight recorder usage for accident investigation and prevention purposes.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Require air carriers to have a procedure for ensuring the operation of cockpit voice recorders before each flight. The procedure should incorporate the use of a headset to ensure that the cockpit area microphone is functioning properly. (Class II, Priority Action) (A-90-70)

Review the current maintenance and inspection programs for users of the Sundstrand V-557 cockpit voice recorders to ensure that they are adequate in providing the information essential to detect and repair discrepancies. (Class II, Priority Action) (A-90-71)

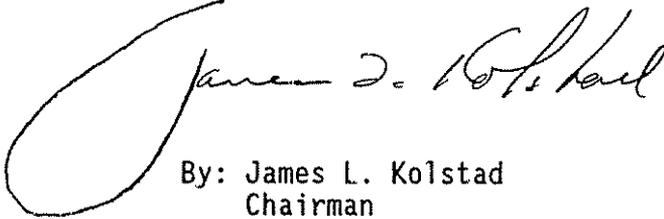
Revise the cockpit voice recorder Technical Standard Order (TSO) to ensure that continuous-recording, self-monitoring features are incorporated within future cockpit voice recorder standards. (Class II, Priority Action) (A-90-72)

Audit flight recorder repair stations to ensure that metal foil recorders repaired for foreign operators are being calibrated properly. (Class II, Priority Action) (A-90-73)

Revise the Master Minimum Equipment List policy regarding cockpit voice and digital flight data recorders to ensure that an inoperative recorder is repaired or replaced within a more stringent timeframe than currently authorized. (Class II, Priority Action) (A-90-74)

Revise 14 CFR Part 129 to require foreign air carriers that operate into the United States, and foreign operators of U.S.-registered aircraft, to adhere to the new U.S. flight recorder standards that were effective on March 25, 1987, and on July 11, 1988. (Class II, Priority Action) (A-90-75)

KOLSTAD, Chairman, COUGHLIN, Acting Vice Chairman, LAUBER and BURNETT, Members, concurred in these recommendations.

A large, stylized handwritten signature in cursive script, appearing to read "James L. Kolstad".

By: James L. Kolstad
Chairman